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Subject Hazards and Accidents Associated with the Operation of the X-10 Reactor

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OAK RIDGE [redacted] LABORATORY

HAZARDS AND ACCIDENTS ASSOCIATED WITH THE OPERATION OF THE X-10 REACTOR

The operating personnel in the pile area at ORNL has experienced the usual accidents such as falls, skinned hands, particles in eyes, etc., which will not be mentioned since they are common to all operating areas. The following is a brief outline of the accidents or near-accidents that have been experienced as a result of the peculiarities of pile operation as well as other accidents or near-accidents of major proportions.

I. Fan Failure

The pile is cooled by two fans enclosed in individual concrete cells and each driven by a 900-HP, 3570-RPM electric motor. The No. 2 fan failed violently on August 8, 1944. It appeared that failure began with the outboard jack-shaft bearing. The balls, raceway, and shaft were severely scored with the concrete pier under this bearing also failing. Five of the six bearings on the assembly were demolished with the jack-shaft being badly bent and the couplings stripped from the end of the motor.

Presence of anyone in the cell at the time of failure very likely would have resulted in a fatality.

The fan was repaired with the jack-shaft eliminated and the fan oiling system revised. In addition to these changes an operator is kept in the building at all times and restrictions established about entrance of personnel to the fan cells during operation of the fans.

However, since there have been thirty-eight bearing failures on the two fans since installation in July, 1944, the fans are to be replaced with sleeve-bearing fans before the end of 1950

II. Removal of Forty-Ounce Gold Sample

A gold sample was irradiated for a few months as a service irradiation with those handling the sample thinking that it weighed forty grams when in reality it weighed forty ounces.

It was pulled into the pile shielding on January 2, 1946 and allowed to cool for one week and pulled out of the shielding on January 9, 1946. The radiation level was 7 R/hr at about six feet.

This error was due entirely to a lack of information as to sample size being transmitted to the Pile Department.

III. Spills and Air Contamination

There have been several cases of spillage of irradiated samples in the 105 Building with one case in which a spill made evacuation of the building necessary.

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It was also necessary to evacuate the building while three exposed "X" slugs were being dissolved in the Hot Laboratory of this building. Ventilation of the Hot Laboratory is not adequate for work of this magnitude.

Early in 1948, the power to a hood ventilation fan was cut off only a few minutes after an experiment had been completed. Failure of the fan during the experiment would have resulted in the necessity of evacuating the building.

While very limited facilities are located in the 105 Building for hot chemical work - and it is held to the minimum here - the experience at this location indicates that, if at all possible, chemical work on hot materials should not be done in the Pile Building.

During July, 1950 a leak developed in a bomb containing a uranium solution. The defective bomb was removed without difficulty, but due to the necessity of changing a gasket in associated equipment, two undamaged bombs were removed. Since the research group wanted to obtain further data on them, they were not vented even though they were under 1500 pounds pressure per square inch. The capillary tube broke on one of the bombs during removal, raised the air count in the building well above tolerance, contaminated the top of the pile to a minor extent, and contaminated one person to the extent that the radiation from him blocked a hand counter while he was standing eight feet away from it. The removal of the contamination was not unusually difficult. The bombs are not to be handled under pressure in the future since a tiny break at such high pressures probably could inject the solution through the skin if the break were close to a person's body.

A particularly difficult problem is faced in the removal, by any other route than the canal, of materials that have been exposed in the pile. All such removals including front face plugs, regulating rods, safety rods, stringers, research equipment, etc. are accompanied with radioactive particulate matter. A very marked reduction in the quantity of radioactive particles being liberated in the building has been made by use of various vacuum cleaning, brushing or wiping systems. However, it is almost impossible to effect complete elimination of these particles.

IV. Slug Ruptures

Since the pile was started in 1943, there have been seventy-five cases of failure of the aluminum jackets on slugs. The worst case was when thirteen slugs failed in Channel 2079. This Channel was completely blocked and the slugs were almost completely oxidized. The slugs could not be removed by the usual means and application of unusually high forces resulted in the slugs sliding over one another and jamming. They were finally removed by special tools but the

graphite in the Channel was broken in the process of removal.

The pile was down for the ten days required for removal of these slugs. Much of the work had to be done with personnel wearing fresh air masks and the 105 Building was contaminated rather badly.

The metal channels of the pile are now being visually inspected weekly. A program of replacement of all slugs in the pile with Al-Si bonded slugs has been authorized. Part of the uranium has been obtained and fabrication and bonding are to be started by Y-12 in the near future.

V. Fan Contamination

The oil leaking out of the fan lubrication system is drawn into the fans, thus forming film which catches a large amount of the dust from slug ruptures.

The failure of thirteen slugs in Channel 2079 caused one of the fans to reach a radiation reading of 30 R/hr at the surface. This reading would have been more than doubled due to beta radiation if the inspection plates had been removed. It decayed down to about 10 R/hr in approximately two months.

The decontamination of this fan was carried out in four stages. Spray nozzles were installed and the fan was washed out by remote means for a few hours on three different occasions. At a later date the fan was decontaminated sufficiently for bearing replacements after thirty-two hours of decontamination work.

Future fan installation should have more serviceable bearings, no oil leaks into fans, and should have provision for remote decontamination in case they are in a contaminated air stream.

Due to the problem of radioactive particulate matter being in the pile effluent air, filters were installed during November, 1948. These filters are in front of the fans to prevent them from picking up further radioactive material.

VI. Slug Removal out of Front Face

The front face plugs have a wood rod on end toward the pile and these some times get loose and are blown back against the slugs. These are removed by a spike on the end of a long rod.

In 1948 during an inspection of the front face, it was thought that there was a wood rod in the hole. The rod with the spike was inserted and the point pierced the slug jacket and bent over when it struck the uranium, hooking the slug. The slug was pulled out of the front face. While it read 2 R/hr at a distance of twenty feet, it was taken to the canal with tongs and no one got over thirty per cent of his daily tolerance exposure.

This probe is now under the strict control of the supervisor and is used only after it has been definitely established that a wood rod is in the hole.

VII. Open Holes

There have been several cases when the pile was almost started up with holes open and a few cases when it was started up with no shielding in some hole through the pile shield.

Some of these were caused by people opening holes while the pile was down without contacting Pile Department supervision. This has been eliminated by better correlation of work and by warning systems.

Shortly after the original start-up of the pile late in 1943, the core hole in the west shield was left open during an experiment with the reactor operating at a low power level. The gates in the protective fence had been locked prior to the start-up of the pile but, unfortunately, some unknown person picked the lock on one of the gates and allowed it to remain open. Three persons visiting the Pile Building walked through the open gate to the west platform and one actually crawled into the large hole in the west shielding. As far as is known, no personal injury occurred; however, it points up rather emphatically the necessity of all visitors checking with operating supervision before wandering aimlessly around a reactor.

On one occasion the pile was run for some time with a front face plug out. The charging elevator was in such a position that it shielded the hole. By the time that the missing front face plug was located the steel on the elevator near the open hole had become so active that it had to be cut out and replaced.

Sufficient detection apparatus has now been installed so that an open hole should be detected as soon as the pile is started. Twelve monitrons, sensitive to neutron radiation as well as gamma radiation, have been installed. These are equipped with alarms that sound when radiation is above daily tolerance levels.

A loud horn sounds for about two minutes as the pile is being started. The start-up of the pile is announced over the public address system, and the fact that the pile is operating is automatically indicated by several signs. The above precautions seem to have eliminated operation of the pile with open holes.

VIII. Faulty Shield

During the preliminary work for a fuel test in Hole 11 by Argonne National Laboratory personnel, it was necessary to remove a stainless steel tube used in heat loss measurements on June 13, 1949. The stainless steel tube was drawn into the eight-inch lead-walled

shield and cut into short pieces with the mechanism within the lead shield prior to transfer to the canal. Radiation readings were as high as 10 R/hr one foot away from the shield. A traverse of the carrier gave extremely variable radiation readings, indicating essentially no lead at spots in the upper half of the shield. The steel shell was cut and the lower 55-60% of the shield appeared to be filled solidly with lead, but the upper portion had void space amounting to perhaps 1500-1800 pounds of lead.

While the shield was not made at this Laboratory, it reportedly had been checked. All thick-walled shields are checked with a gamma source prior to use since this incident.

IX. Mattress Plates

In order to break the fall of discharged slugs and direct them into a chute, neoprene-covered mattress plates are used. Even though a stream of water is kept running constantly on these plates, the neoprene fails in a year or so due to heat, usage, and radiation damage and must be replaced. Replacement of these plates is a slow, difficult job resulting in considerable exposure to personnel.

Future installations could be much better designed for removal and perhaps designed so as to give longer use between replacements.

September 25, 1950